

CBO PAPERS

DESCRIPTION OF ECONOMIC MODELS

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PREFACE

The report accompanying the House Legislative Branch Appropriations Bill for 1999 (Report 105-595) directed the Congressional Budget Office (CBO) to provide certain information to the leadership of the Congress. Among other things, the Committee asked CBO to provide a detailed description of the various models used by CBO in preparing its economic forecasts and analyses. This paper is a summary of CBO's response to that request.

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Sherry Snyder edited the paper, and Chris Spoor proofread it. Verlinda Lewis Harris typed early drafts of the paper; Dorothy J. Kornegay prepared the manuscript for final publication. Laurie Brown prepared the electronic versions for CBO's World Wide Web site (<http://www.cbo.gov>).

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Director

November 1998

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INTRODUCTION

The U.S. economy is the largest and arguably the most complex in the world. Every day, millions of Americans are making economic decisions. Consumers are choosing among a vast array of goods and services and deciding how much income they want to save and where they want to invest it. At the same time, firms are making decisions about hiring workers, about investing in new plants, equipment, and technology, and about what and how much to produce. And at some point, everyone has to make important life decisions about work—deciding, for example, whether to take a job for the first time or leave the workforce to care for children, go to school, or retire.

Government policies can influence all of those decisions. Higher marginal tax rates can reduce work effort, discourage saving, and slow the growth of the economy. Changes in entitlement programs for the elderly can influence people's decisions about retirement and saving for the future. Reducing the budget deficit can boost the U.S. capital stock, lower interest rates, and raise gross domestic product. Increased regulation and governmental mandates can reduce productivity.

In addition, world events can affect the economy. An economic storm in Asia can roll across the Pacific. War can break out in the Middle East. World oil prices can shoot up. Stock markets can drop, and business and consumer confidence can collapse.

The Congressional Budget Office (CBO) considers a wide range of factors in developing its economic projections. The agency examines recent data on the state of the economy, looks at historical relationships among economic variables, analyzes the results from formal economic models, and compares its economic projections and analyses with those of private forecasters and economists. CBO relies on economic models to help weave those different threads of information into meaningful patterns.

CBO does not rely on a single economic model for good reasons. Economic models are only stylized representations of the economy and thus cannot capture all of the important features of the complex U.S. economy. Models make different simplifying assumptions, which implies that they have different strengths and weaknesses. Some models, for instance, may provide considerable detail about the U.S. tax system but may ignore the flows of capital across borders. And although other models may focus on those capital flows, such models may have only a simple set of equations for the tax system. Because models differ in their assumptions, it is important to consult different models when developing projections.

Economists' models of the macroeconomy have changed dramatically over the past 30 years. In the 1960s, simple Keynesian models formed the basis of macroeconomic policy analysis and forecasting. At that time, most forecasting models focused on the demand for goods and services and gave little thought to

aggregate supply. Not surprisingly, those models performed badly in the 1970s, when the economy suffered a series of supply-side shocks from the sharp rise in oil prices and the slowdown of productivity growth. Since then, most macroeconomic modelers have added equations for the supply side of the economy. All of the models taken seriously by CBO include supply-side equations.

ECONOMIC PROJECTIONS UNDER CURRENT LAW

The Congressional Budget and Impoundment Control Act of 1974 requires CBO to issue an annual report to the Congress presenting budget projections that take account of economic factors. In fulfilling that statutory obligation, CBO prepares a detailed set of 10-year economic projections. The most important macroeconomic variables for budget projections are gross domestic product (GDP), interest rates, inflation, and the shares of income allocated to wages, profits, and interest. The income shares are important for the budget projections because the various components of GDP are taxed at different effective rates. With few exceptions, CBO's projections take current law as given and assume that federal tax and spending policies will not change.¹

CBO's forecasts reflect its best estimate about the future course of the economy. Because the future is uncertain, CBO, when developing its economic forecasts, considers a range of alternative scenarios and the likelihood of their occurring. One scenario, for instance, may assume that GDP will enjoy an exaggerated boom and then suffer a drawn-out bust. Another scenario may assume that productivity will surge and the economy will grow much faster than expected. Sometimes those scenarios are formally explored using large-scale macroeconomic models; sometimes, they are examined more informally.

CBO's analysis of the economic outlook has two parts: the near-term forecast (for the first two years) and the medium-term projections for the rest of the 10-year period. For the two-year forecast, CBO allows for an explicit consideration of cyclical movements of the economy. For the medium term, however, CBO does not forecast such temporary movements. Instead, it assumes a growth path for the economy that reflects the average chance of booms and recessions. CBO uses data from different sources to identify underlying economic trends, such as growth of the labor force, the rate of national saving, and the growth of productivity. The projections of real (inflation-adjusted) GDP, inflation, and real interest rates depend on those underlying trends. In addition, CBO modifies the projections to reflect changes in government policies that are likely to have an appreciable impact on the economy.

1. From 1995 to 1997, CBO also published economic projections that showed the effects of balancing the budget.

Economic Growth

Economic growth for both the two-year forecast and the medium-term projection is heavily influenced by CBO's estimate of potential GDP. Potential GDP is estimated as the highest level of output the economy could achieve without increasing the rate of inflation. Potential GDP reflects the supply side of the economy.

Although CBO's medium-term projection for real GDP is similar to its projection for potential GDP, the agency's near-term forecast for real GDP can differ significantly, depending on the likelihood of an economic boom or a recession. Nonetheless, potential GDP also plays an important role in forecasting the economy's performance in the near term. For example, if aggregate spending on goods and services outstrips potential supply and the economy is not expected to cool down on its own, CBO assumes that the Federal Reserve will act to restrain aggregate demand and keep inflation from growing out of control.

Potential GDP and CBO's Medium-Term Projections. CBO estimates potential GDP by using a neoclassical model of economic growth.² The nonfarm, nonhousing business sector is at the core of CBO's model. The growth of that sector's output depends on the growth of hours worked, capital, and productivity. In the model, the more hours worked, the more firms invest in new plants and equipment and the more technology advances, the higher the potential GDP.

CBO uses a variety of information to develop its projections of the total number of hours worked, including population growth, labor force participation, and average weekly hours. CBO also compares its results with those of other forecasters. CBO's most recent projections for the labor force, for example, are similar to those made by the Bureau of Labor Statistics, as well as Macroeconomic Advisers (a private forecasting group), but are more optimistic than the Social Security Administration's. CBO's projections for the labor force also reflect the effects of changes in government policy. In January 1997, for instance, CBO first incorporated into its projections the effects of the Personal Responsibility and Work Opportunity Act (also known as welfare reform) on expanding the size of the labor force.

The expected growth of the real capital stock reflects CBO's projections of domestic investment, the prices of investment goods, and depreciation. Funds for domestic investment come from private and government saving as well as borrowing from foreigners. Other things being equal, larger budget surpluses increase government saving, which raises national saving, reduces borrowing from abroad, and boosts the capital stock and potential GDP. CBO keeps track of four separate types

2. For more details, see Congressional Budget Office, *CBO's Method for Estimating Potential Output*, CBO Memorandum (October 1995).

of nonhousing business investment: computer equipment, noncomputer equipment, structures, and inventories. CBO expects prices of those four types of capital investment to follow historical trends with adjustments for recent developments. Assumed depreciation rates reflect their historical values.

Technological advance is captured by the growth of total factor productivity (TFP), which is that part of output growth not explained by the growth of capital and labor inputs. CBO's projections assume that the future growth of TFP will follow its trend since 1981. Although some economists have speculated that the economy has entered a new era of faster productivity growth, the data reveal little evidence of such a change. Both TFP and labor productivity (which reflects the growth of both TFP and capital) are still growing in line with long-standing trends (see Figure 1). The neoclassical model of economic growth, which CBO uses, assumes that TFP is exogenous—that is, not determined by the model's equations. Some economists have developed new models of economic growth to explain the growth of TFP, but the empirical evidence tends to support CBO's approach.³

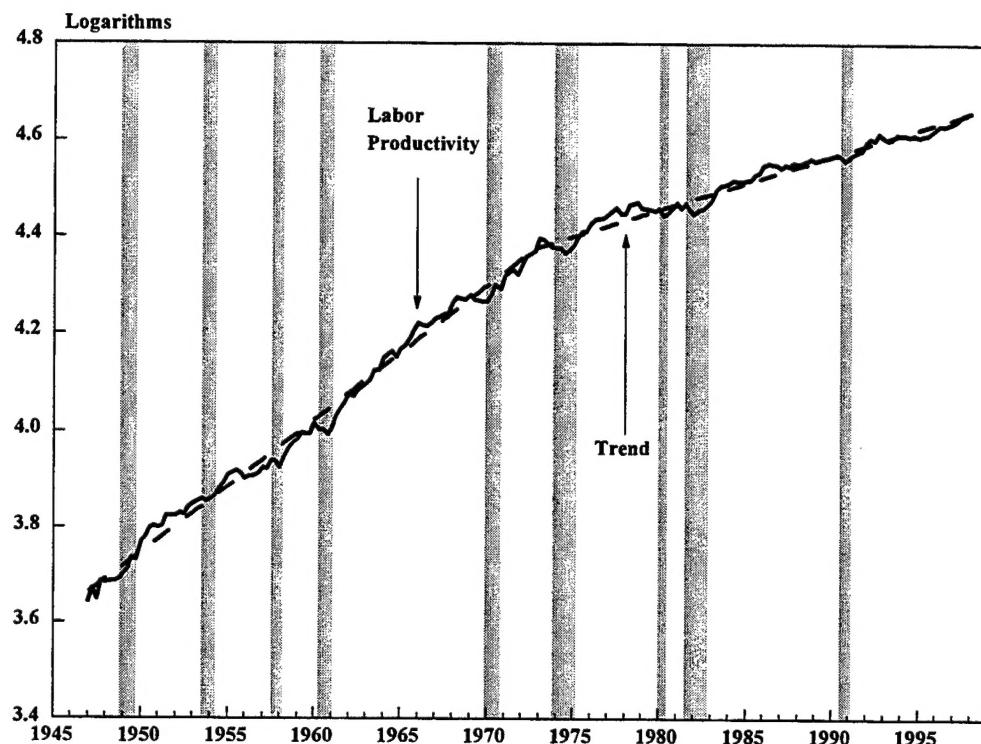
Although CBO does not forecast cyclical movements in the economy for the medium term, its methodology allows for the possibility of a recession. In particular, CBO assumes that GDP will be 0.2 percent less than potential GDP after 2001, which is the average gap between actual and potential GDP observed over time.

Near-Term Forecast. CBO analysts look at many economic indicators to develop a view about the near-term growth prospects of the economy. That analysis includes examining data on retail sales, disposable income, employment, consumer confidence, orders for and shipments of new capital equipment, new housing starts, sales of existing homes, net exports, foreign growth and inflation, governmental receipts and spending, interest rates on government and corporate securities, stock prices, commodity prices, inflation rates, exchange rates, the growth of the money supply, and overall credit conditions.

CBO also uses statistical methods to better understand recent economic developments. When new data on monthly retail sales are released, CBO analysts use that information to predict the likely path for the growth of overall consumption during the quarter. Monthly data on shipments of capital goods are used to predict

3. For more details, see Congressional Budget Office, *Recent Developments in the Theory of Long-Run Growth: A Critical Evaluation*, CBO Paper (October 1994).

FIGURE 1. LABOR PRODUCTIVITY AND ITS UNDERLYING TREND



SOURCE: Congressional Budget Office using data from the Department of Labor, Bureau of Labor Statistics.

NOTES: The shaded vertical bars indicate periods of recession. The bars extend from the peak to the trough of the recession.

The trend has a break in 1973.

the current quarter's investment. Monthly data on average hourly wages and total hours worked are used to forecast private wages and salaries. CBO then reconciles those "bottom-up" projections of individual components with "top-down" assumptions about overall economic growth through a framework of accounting identities that ensure that the uses of income (consumption, investment, net exports, and government) add up to the total sources of income (wages, profits, interest, depreciation, and other items).

CBO also looks at developments on the economic horizon that have not yet affected the economy but are expected to come into play in the near future. For example, the crisis in Asia became apparent in the summer of 1997, but its effects on

the United States at that time were primarily limited to the foreign exchange markets. In its January 1998 report, CBO's projections incorporated the view that the Asian crisis would reduce U.S. net exports and would slow the growth of the economy. Those estimates were based on a statistical analysis of historical relationships between exchange rates, foreign growth, and net exports, as well as a judgment about the specific nature of the crisis.

An important part of CBO's forecast involves assumptions about the policy reactions of the Federal Reserve. When GDP is above potential output, underlying inflationary pressures are building. In that situation, CBO assumes that unless GDP growth slows enough on its own to eliminate the excess demand for goods and services, the Federal Reserve will take steps to restrain growth by raising interest rates. Conversely, when the economy is operating below its potential and the labor force is underemployed, CBO assumes that the Federal Reserve will provide sufficient economic stimulus so that GDP will eventually climb back to its potential level.

Despite their best efforts, all forecasters can be wrong in one way or another. Part of that simply reflects an inevitable uncertainty about future events. But some errors may be correctable. To strengthen its ability to find and correct errors, CBO routinely examines the accuracy of its macroeconomic forecasts and publishes statistics on its forecast errors each summer in *The Economic and Budget Outlook: An Update*.

In general, CBO's forecasts and projections have been as precise as those of other forecasters.⁴ For the two-year forecasts of real GDP growth made between 1982 and 1995, CBO had an average error of 0.1 percentage point, slightly better than the Administration's record and about the same as the average of the 50 private forecasters surveyed monthly in *Blue Chip Economic Indicators*.

In the end, a forecast is more than just a set of numbers; it also explains where the economy is going and why. To help sort out alternative scenarios, CBO compares its projections with private-sector forecasts and carries out scenario analysis. CBO routinely examines the *Blue Chip* forecasts as well as the detailed macroeconomic forecasts prepared by three large macroeconomic services—Data Resources Incorporated (DRI), Macroeconomic Advisers, and the WEFA Group. Scenario analysis involves simulating macroeconomic models under different conditions. Those scenarios help CBO to understand the range of possible outcomes and reflect those possibilities in developing its best estimate for real growth.

4. See Congressional Budget Office, *The Economic and Budget Outlook: An Update* (September 1997), Appendix A.

Inflation

In the long run, sustained growth in the money supply relative to the growth of the productive capacity of the economy will create inflation. However, the link between money and inflation is uncertain for three reasons. First, the actual level of productive capacity is uncertain. Second, monetary policy actions affect demand with long and variable lags. Third, innovations in financial markets continually alter the technology of payments that determines the amount of economic activity a given quantity of money can support. Those innovations also make it difficult to find the evolving line between money and other closely related financial instruments that do much the same job.

Practical forecasts of inflation in the United States thus must look beyond money to other indicators of the level of demand relative to productive capacity. One of the most important such indicators is the state of the labor market. When labor markets are tight, employers have to raise wages to attract workers to their firms. Unless those wage gains are matched by increases in productivity, they will raise the firms' unit labor costs. Although higher production costs may squeeze profits, they will eventually put upward pressure on prices.

Economists have formalized those ideas in a model, the so-called "expectations-augmented Phillips curve," which CBO uses to forecast inflation. In that model, if the unemployment rate is below the NAIRU (nonaccelerating inflation rate of unemployment), the inflation rate tends to rise.⁵ Conversely, inflation will ease if the unemployment rate is above the NAIRU. Another important feature of CBO's model is that higher inflation rates will eventually create expectations of higher inflation. CBO's model also explicitly incorporates Milton Friedman's view that there is no long-run trade-off between inflation and unemployment.⁶

CBO estimates that the NAIRU is currently 5.6 percent. That estimate is based on historical evidence of the relationship between inflation and the unemployment rate. In its estimate, CBO assumes that the NAIRU for married males has remained constant over time. However, changes in the demographic composition of the workforce will affect CBO's estimate of the NAIRU for the overall economy. For example, because young people and other less experienced workers tend to have high unemployment rates, the NAIRU rose nearly a full percentage point during the 1960s and 1970s, when a flood of less experienced workers joined the labor force. As that cohort grew older and gained skills, the overall level of the NAIRU declined.

5. Congressional Budget Office, *The Economic and Budget Outlook: An Update* (August 1994), Appendix B.

6. Milton Friedman, "The Role of Monetary Policy," *American Economic Review*, vol. 58, no. 1 (March 1968), pp. 1-17.

CBO includes two other factors in its NAIRU model. First, it incorporates measures of food and energy prices, which are volatile and can rise and fall sharply for reasons unrelated to the underlying state of the economy. Second, CBO includes a measure of the deviation of productivity from its underlying trend. Other things being equal, a temporary increase in productivity above the trend will ease inflationary pressures.

CBO's approach to modeling inflation is generally consistent with the economy's experience in the postwar period. The history of the 1960s and 1970s provides strong evidence that labor markets cannot operate at low unemployment rates without risking a rise in the inflation rate. More recently, when the unemployment rate fell below 6 percent in the late 1980s, the core inflation rate (as measured by the percentage increase in the consumer price index excluding food and energy) increased from about 4½ percent to over 5 percent.

In the late 1990s, however, the behavior of inflation has been somewhat puzzling. Although inflation should have risen in response to tight labor markets, core inflation has remained relatively subdued. CBO has examined the data and found that four factors can explain the puzzle. First, the dollar's appreciation caused import prices to decline sharply in 1996 and 1997, which put downward pressure on the U.S. inflation rate. Second, computer prices have been falling at extraordinarily fast rates in recent years. Third, the growth of private medical prices slowed because of institutional changes in the provision of medical care. Fourth, the Bureau of Labor Statistics has changed the way it measures inflation, reducing the estimate of inflation by about one-half of a percentage point since 1994.⁷ At some point, however, those special factors will stop masking the underlying pressures in labor markets, and inflation may begin to rise.

Interest Rates

CBO prepares forecasts of the interest rates on three-month Treasury bills and 10-year Treasury notes. For the first two years, the forecast of the three-month Treasury

7. Many economists have raised concerns about the government's measures of inflation, productivity, and real growth and argued that the national statistics overstate inflation and understate real growth. Although government statisticians have taken steps to reduce the bias, some bias remains stemming from the inherent difficulty of measuring changes in the quality of goods and services available to consumers and businesses. The growth of computer software, for example, raises some important measurement issues. See Congressional Budget Office, *Changing the Treatment of Software Expenditures in the National Accounts*, CBO Memorandum (April 1998). Those measurement problems do not greatly affect CBO's projections of the budget surplus. The surplus is measured in current dollars, not inflation-adjusted dollars. As a result, CBO's projections of the surplus depend largely on economic variables—such as nominal GDP, wages and salaries, and corporate profits—that are expressed in current dollars. The split of nominal GDP growth into real growth and inflation is much less important.

bill rate largely reflects CBO's assumptions about monetary policy. If the economy is racing above potential, CBO assumes that the Federal Reserve will raise interest rates enough to slow the rate of growth.

In the medium term, CBO assumes that real interest rates are governed by the fundamental forces of saving and investment, and the agency develops its projections by making comparisons with other historical periods. In the early 1960s, for instance, the economy had stable inflation, modest budget surpluses, a high rate of private saving, and low real interest rates. The current economic environment is similar to the early 1960s, except that private saving is lower. CBO therefore expects that real short-term interest rates will be slightly higher in the future than they were in the 1960s.

CBO's projections of interest rates reflect changes in the government's fiscal position. For example, because deficit reduction increases government saving, it reduces pressures on the credit markets and allows interest rates to fall. The additional saving also increases investment and boosts economic growth. When the Congress was considering proposals to reduce the federal budget deficit, CBO prepared analyses of how deficit reduction would affect the economy and predicted that deficit reduction would produce a "fiscal dividend" from lower interest rates and higher growth. That analysis was published in CBO's *An Analysis of the President's Budgetary Proposals for Fiscal Year 1996* (April 1995) and was then updated in three consecutive years of *The Economic and Budget Outlook* (1995, 1996, and 1997).

In developing its projections of the interest rate on 10-year Treasury notes, CBO assumes that financial markets are forward looking and that long-term interest rates today will reflect investors' expectations of future short-term interest rates. Therefore, when it estimated the effects of balancing the budget, CBO assumed that long-term interest rates would decline before short-term rates.

Income Shares

For CBO, one of the most important parts of the economic projection is forecasting incomes—that is, wages and salaries, corporate profits, proprietors' income, interest income, dividends, and so on. CBO emphasizes those variables more than many other private forecasters do because CBO is particularly interested in forecasting government revenues. Revenue projections are directly tied to the projections of incomes.

In principle, the sum total of all types of income ought to add up to GDP because the value of a product sold reflects the payments to the people who made or

distributed it. Thus, CBO's projections of income growth generally follow closely its projections of nominal GDP.

The projections are complicated, however, by errors in the historical measurement of both GDP and income, which means that the measured values of the two are not the same. Measured income has, in recent years, grown substantially faster than measured GDP, and the gap has widened to about \$100 billion. One of the forecaster's tasks, therefore, is to anticipate what will happen next to that statistical discrepancy. CBO has generally presumed, as have other forecasters, that the statistical discrepancy will not continue to grow indefinitely.

Leaving aside the issue of the statistical discrepancy, CBO's main task is to decide how GDP will be divided into the various categories of income. CBO first considers how much income is likely to go to workers in wages, salaries, and fringe benefits (which include employers' contributions to social insurance taxes and contributions to health and pension plans). The standard economic model assumes that workers will be paid according to their productivity (technically, their "marginal product"). Another standard technical assumption suggests that workers so paid will earn a constant share of total income. Over long periods of time, that assumption is fairly well supported, although significant short-run variations have occurred in the share of income going to workers. The share tends to go up in recessions and down in prolonged booms, such as the United States has experienced since 1992. CBO's projections therefore have to reflect that cyclical variation.

The fringe benefits that workers receive are not taxable, so the next step is to subtract them from the overall figures for workers' total compensation.⁸ The most variable elements of fringe benefits are employers' contributions for health insurance and pension plans. Fringe benefits have historically grown substantially faster than wages, reflecting both the increased coverage of health and pension plans and the rapid growth of health care costs. In the past few years, premiums for health insurance have grown more slowly, but anecdotal evidence suggests that the growth rate may have picked up recently. Future growth in those premiums reduces the proportion of overall employee income that is subject to tax.

Income from employment accounts for most of the income tax base and for all the social insurance tax base. Another major tax base is corporate profits, which form part of overall capital income. The same theory that predicts constancy in workers' share of income also predicts that the share going to all types of capital income will stay constant. In practice, however, capital income, like labor income,

8. The value of fringe benefits is difficult to measure, which could affect CBO's forecast of the economy and tax revenues. See Congressional Budget Office, *Measurement of Employee Benefits in the National Accounts*, CBO Memorandum (September 1998).

is affected by cyclical movements in the economy. Profits and other capital income tend to go down in recessions and to do particularly well in prolonged booms.

Projections of profits have to take into account estimates of how much of overall capital income goes to proprietors' income, interest income, and other forms of capital income and how much goes to depreciation. Projecting the share of income that goes to proprietors is important because the larger the share, the lower federal revenues are likely to be. (Proprietors do not have a particularly good record of complying with the income tax.) Generally, CBO assumes that the proprietors' share will be approximately constant.

Projections of interest income are more complex and have to take into account both interest rates and the propensity of firms to take on debt. Experience suggests that interest income rises when interest rates are high and mergers are booming, as occurred in the 1980s. A boom in mergers, which may again be under way, raises corporate interest costs, boosts interest income, and reduces corporate profits. A rise in the interest share of income also reduces revenues because much interest income goes to entities (such as pension funds) that are not taxable and to taxpayers (particularly wealthy ones) who tend to hold tax-exempt bonds.

The last important component of income to consider is the projection for depreciation. The model of depreciation starts from the history and projections of purchases of capital equipment and nonresidential structures. The model assumes depreciation schedules for different classes of equipment and structures that reflect current law. The model cannot reflect perfectly the time pattern of depreciation because information is lacking on the detailed allocation of investment to different classes. However, the fact that depreciation over the life of an asset must eventually equal its purchase price prevents the model from going persistently astray.

The projection for depreciation beyond the very short term clearly depends on the underlying projection of investment. In the past few years, the U.S. economy has had a dramatic boom in investment fueled by low interest rates, a strong stock market, and declining prices for capital goods associated with computers. Most forecasters expect the investment boom to continue, though at a reduced pace. In real terms, depreciation will consequently rise, reflecting the recent strength in investment and the further growth anticipated, as well as the shift toward shorter-lived capital assets. Whether nominal depreciation also rises will depend on how fast prices of capital goods fall. Any rise in nominal depreciation will constrain the growth of corporate profits.

Several of the income measures discussed above are highly sensitive to the business cycle. CBO does not currently expect a recession before the end of 1999 and does not try, in its projections beyond the first two years, to predict the timing of

business cycles. Nevertheless, it would be foolhardy to assume that no recession will occur in the next 10 years. CBO's projections of incomes, like its projections of overall GDP, try to take into account the likelihood of a recession sometime in the period. Allowing for a recession pushes up CBO's projections of the share of income going to wages and pushes down the projections of the share going to profits. Some components, such as depreciation and interest payments, are relatively insensitive to the business cycle. Because a recession reduces overall income, the shares of those relatively insensitive components rise modestly during recessions, and that also pushes up CBO's projections.

Uncertainty

CBO's baseline projections represent the expected average behavior of the economy. As a result, the economy's projected path is much smoother than its actual history. But the economy rarely grows as smoothly as potential GDP. Most of the time, real GDP is either above potential (most notably, as it was for the latter half of the 1960s) or below potential (as it was during the recessions of the early and mid-1970s and early 1980s). Because real GDP has fluctuated around its potential in the past, it will probably continue to do so. Moreover, considerable uncertainty surrounds the long-run growth of potential GDP.

In a recent report, CBO examined a series of alternative assumptions about the economy and the effect those alternatives would have on budgetary outcomes.⁹ That analysis revealed that the budget deficit is quite sensitive to different assumed paths for the economy.

In that study, CBO examined two broad sets of alternative economic assumptions. The first set looked at differences of 0.5 percentage points in the economy's long-run rate of growth. The growth rate of potential output has varied substantially over the past 30 years, as have the two main factors that drive its growth: growth in the labor force and in output per hour. Average annual growth of potential output has ranged from a high of 3.9 percent (1960-1973) to a low of 1.9 percent (1990-1996). In CBO's January 1997 baseline, potential output grew at an average annual rate of 2.1 percent from 1996 to 2007. An increase or decrease of 0.5 percentage points in that growth rate would not have been inconsistent with past trends and could have decreased or raised the deficit by \$50 billion in fiscal year 2002. Moreover, those effects would have continued to grow over time.

9. Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 1998-2007* (January 1997), Chapter 3.

The second set of assumptions looked at the effects of different types of cyclical disturbances in the economy. Predicting the exact size and timing of those fluctuations is impossible, although some broad inferences about the kind of fluctuations can be drawn from the experience of the economy. In the late 1960s, for example, the economy spent a considerable period growing above potential, and CBO selected that experience in one of its simulations. In a more pessimistic alternative, CBO assumed that the economy experienced a recession roughly the size of the 1990 recession sometime during the projection period. A fairly typical swing in the business cycle would increase or decrease the deficit by more than \$100 billion in a given year. In contrast to the effect of a shift in the growth of potential output, the effect of the business cycle on the budget would largely fade away over time.

All of those alternative assumptions were constructed to roughly mimic historical patterns. However, the pattern of economic fluctuations rarely, if ever, repeats itself. The factors contributing to each upswing and subsequent downswing in the economy vary with each episode. In fact, the uniqueness of each episode accounts in part for the difficulty in predicting turning points in the business cycle. Thus, although one can safely say that the economy will experience business cycles in the future, predicting their exact timing or detailed causes is impossible.

LONG-TERM ECONOMIC PROJECTIONS

For some time, policymakers have been concerned about the budgetary and economic effects of the retirement of the baby-boom generation and the continued growth of costs per enrollee in federal health care programs. To help illustrate those effects, CBO developed a model for making long-term economic and budget projections.¹⁰ The model contains equations that account for the chief feedbacks between the budget and the economy. Those equations trace the way in which output depends on capital and labor and hence on the budget and population.

Budget Assumptions

Developing computer models of the long-term implications of existing laws and policies requires making assumptions about the basic nature of policy in the absence of change. Those assumptions form a base scenario; varying them produces alternative scenarios.

10. For a discussion of CBO's latest long-term projections and analysis, see Congressional Budget Office, *Long-Term Budgetary Pressures and Policy Options* (May 1998). For a description of the model, see Congressional Budget Office, *An Economic Model for Long-Run Budget Simulations*, CBO Memorandum (July 1997).

For the 1998-2008 period, CBO's long-term projections simply follow its 10-year baseline projections. Taxes and mandatory spending reflect current law, and discretionary outlays grow with inflation, subject to their statutory caps. CBO did not try to extend its regular budgetary projections beyond 2008. Instead, it simply assumed that spending would grow according to some simple and reasonable rules.

Retirement Programs. CBO based its projections for Social Security on the long-term projections prepared by the trustees of the Old-Age and Survivors and Disability Insurance Trust Funds. CBO adjusted those projections for differences between its economic assumptions and those of the trustees. Because CBO projected much lower rates of inflation than did the trustees, the level of Social Security outlays is much lower in CBO's projections than in the trustees' projections. But when outlays are expressed as a share of GDP, the differences between CBO's projections and those of the trustees are small because low inflation also reduces nominal GDP. Spending for federal civilian and military retirement was based on the projections prepared by the Office of Personnel Management and the Department of Defense. CBO adjusted those projections for differences in assumptions about the growth of real wages.

Health Programs. CBO based its projections of Medicare outlays on the forecasts prepared by Medicare's trustees. Those forecasts were also adjusted for differences in economic assumptions. Again, those differences are small when spending is expressed as a share of GDP.

CBO assumed that Medicaid spending would grow with the demand for Medicaid as the population ages and with increased federal health care expenditures per beneficiary. Over the 2008-2020 period, growth in spending per enrollee of a given age was assumed to decline gradually to the rate of growth of hourly wages.

Defense and Nondefense Goods and Services. These federal expenditures are largely discretionary, and funds for them are appropriated annually. In its base scenario, CBO assumed that discretionary spending would grow at the same rate as the economy after 2008. In an alternative projection, CBO assumed that discretionary spending would grow at the same rate as inflation.

Other Transfers, Grants, and Subsidies. CBO assumed that spending for other domestic transfers would grow with demographic demands, inflation, and labor productivity. Domestic transfers include food stamps, Supplemental Security Income, unemployment insurance, the earned income tax credit, and veterans' benefits, among other programs. Other grants include outlays for programs that replace the former Aid to Families with Dependent Children and other federal programs that transfer funds to state and local governments. Those grants, transfer

payments to foreigners, and other subsidies were assumed to grow at the same rate as discretionary spending.

Receipts. CBO assumed that federal taxes would grow at the same rate as the economy after 2008. That assumption is consistent with long-term historical trends.

Economic Assumptions

CBO developed its long-term simulations of the economy using a neoclassical model of economic growth. In that model, which is similar to the one CBO uses to estimate potential GDP and prepare its 10-year projections, the production of goods and services in the economy depends on hours of labor, capital, and total factor productivity.

CBO's model also accounts for the way the nation's debt (the total amount that the government explicitly owes) interacts with the economy. As deficits rise, they crowd out capital investment, raise interest rates, and slow economic growth. In turn, the growth in tax revenues declines, and the cost of servicing the debt goes up. Such economic feedbacks between the deficit and the economy can significantly increase the size of the deficit—in essence, imposing a fiscal penalty.

From 1998 to 2008, the base scenario follows the medium-term projections presented in CBO's January 1998 report, *The Economic and Budget Outlook: Fiscal Years 1999–2008*. For the years after 2008, CBO makes four important assumptions about the economy. First, the annual growth in hours of work slows to a crawl as the baby boomers leave the workforce or otherwise reduce their average hours of work. Consequently, total hours in the nonfarm economy, which grew at an average annual rate of 1.6 percent from 1979 through 1997, is expected to slow to a 0.2 percent average annual growth rate between 2010 and 2030. Second, the growth of total factor productivity rises by 1 percent each year, approximately equal to its growth rate in the post-World War II period. Third, rising deficits crowd out capital investment and slow the growth of the capital stock. The effect of the deficit on capital investment in those projections is assumed to be partially offset by increased private saving and by borrowing from abroad. Finally, inflation remains steady after 2008.

MACROECONOMIC POLICY ANALYSIS

CBO also uses macroeconomic models to analyze the economic effects of changes in federal policy. That analysis spans a broad range of policies from changes in tax law to balancing the budget. CBO publishes the analysis of proposed policy changes

in its reports, studies, papers, memorandums, and letters to the Congress. Once a proposal is enacted into law, its effects are incorporated into CBO's baseline forecast of the economy and published in the agency's annual report to the Congress, *The Economic and Budget Outlook*. This section briefly reviews some of the macroeconomic policy analysis that CBO has recently done.

Fundamental Tax Reform

In the past two years, a significant number of proposals have been made for comprehensive reform of the federal tax system. The current system relies largely on a progressive tax on individual income, a tax on corporate income, and a proportional or flat tax on wages (the payroll tax that finances Social Security and Medicare) up to a taxable maximum. Most of the attention has been on reforming the income tax portion—by flattening the rate structure and eliminating many of the deductions and exclusions permitted under current law, integrating business and personal taxes, and eliminating the tax on capital income by taxing consumption instead of income.

Such proposals are put forward largely because they are thought to offer economic benefits such as removing disincentives for saving and investment and increasing economic efficiency. Analyzing and quantifying the benefits of fundamental tax reform is challenging. Because such reform would necessarily go beyond historical experience, evidence from previous reforms would be of only limited help. Therefore, any analysis of the current proposals must also depend on theoretical models of economic behavior.

In January 1997, the Joint Committee on Taxation (JCT) held a symposium on modeling fundamental tax reform.¹¹ The symposium was the culmination of a yearlong project to learn more about the economic modeling of tax policies. The JCT gathered together several modeling experts who were asked to examine certain hypothetical, but carefully specified, tax reforms.

In collaboration with academic economists, CBO staff contributed two papers to the symposium, describing the results of their economic models. (Those papers were released in an October 1997 CBO memorandum, *Two Papers on Fundamental Tax Reform*.) One model was developed by Alan Auerbach, Laurence Kotlikoff, Kent Smetters, and Jan Walliser and the other, by Don Fullerton and Diane Rogers. Diane Rogers is a current member of the CBO staff; Kent Smetters and Jan Walliser are former CBO staffers; Alan Auerbach is a professor at the University of California

11. Joint Committee on Taxation, *Joint Committee on Taxation Tax Modeling Project and 1997 Tax Symposium Papers*, JCS-21-97 (November 20, 1997).

at Berkeley; Laurence Kotlikoff is a professor at Boston University; and Don Fullerton is a professor at the University of Texas at Austin.

The modelers looked at two particular versions of fundamental tax reform. The first type of reform would replace the current multiple-rate income tax with a single-rate system. It would also broaden the base of income taxes and integrate business taxes with personal taxes. The base broadening would be comprehensive, encompassing many items currently excluded from tax. Thus, it would eliminate deductions for mortgage interest, charitable contributions, and state and local income and property taxes. It would also tax currently exempt fringe benefits such as health insurance.

The second type of reform would substitute a broad-based consumption tax for the current personal and corporate income taxes. The proposal defines that base indirectly, by taxing income at a flat rate and allowing businesses to deduct their capital expenditures immediately rather than as their equipment depreciates. Businesses would also deduct their wages and costs for fringe benefits, and those payments to labor would be taxed at the personal level rather than the business level.

A proper macroeconomic evaluation of tax reform requires models that can capture how taxes affect decisions about both labor supply and the timing of consumption. The two models that CBO used are well suited for that purpose. They are supply-side models that explicitly show how households and businesses respond to changes in tax policy. The models differ, however, in some respects. A switch toward consumption-based taxes increases national saving and economic output in both models. By contrast, a switch to a single-rate income tax reduces GDP in one model but increases it in the other model.

Results from the two models, taken together, help to advance an understanding of the economic effects of fundamental tax reform and the influence of a model's structure and assumptions on the predicted effects. Of course, neither model addresses all of the issues raised by fundamental tax reform. Each is designed to emphasize particular mechanisms. The results of the two models must be considered in conjunction with findings from other models—and with careful attention to theory and data—to arrive at a comprehensive view of the effects of tax reform. CBO addressed the broad issues surrounding such major reforms in a July 1997 study, *The Economic Effects of Comprehensive Tax Reform*.

1997 Budget Reconciliation Package

Last summer, CBO analyzed the economic effects of the 1997 budget reconciliation package and published the results of its analysis in *The Economic and Budget*

Outlook: An Update (September 1997). The package, which consisted of the Balanced Budget Act and the Taxpayer Relief Act of 1997, cut the deficit by decreasing the projected growth of spending, even though certain tax reductions offset part of that decrease. The principal changes in tax law provided lower rates on capital gains, new and expanded individual retirement accounts, less exposure to the estate tax and the alternative minimum tax, stronger incentives to obtain a postsecondary education, and credits for children under the age of 17. Some tax provisions would raise revenue, mainly by altering and extending the airline ticket tax through 2007.

CBO analyzed the new law using a variety of approaches. The agency surveyed the empirical literature on the effects of taxes on the economy. It also simulated the proposed policies using the Auerbach-Kotlikoff-Smetters-Walliser model and compared its results with those of other researchers. For some provisions of the law, CBO used data from the Current Population Survey and the Internal Revenue Service's Statistics of Income, along with estimates of labor-supply elasticities, to estimate the legislation's effects on the labor market.¹² CBO concluded that although the legislation would affect most people, its overall impact on the economy in the next 10 years was likely to be small.

General Considerations. The economic effects of the package stem largely from lower deficits. A deficit reduction raises national saving and leads to lower interest rates and higher GDP. The reductions in the deficit under the new legislation, however, are too small relative to the economy to lead to a large increase in national output.

The legislation may also affect the economy by changing marginal tax rates—the rates that apply to the last dollar earned. Lower marginal taxes on income from labor or capital are likely to encourage people to work more or consume less. Some provisions directly change effective marginal rates; for instance, the new law reduces the statutory tax on capital gains. Other provisions modify marginal rates indirectly by phasing out credits, deductions, or exclusions according to income.

Taxpayers who fall in the phaseout range will pay more tax than otherwise on an extra dollar of income. Changes in marginal tax rates under the new law are individually small and partly offsetting and should have little overall effect on work or saving.

People are also likely to change their behavior to the extent that the new legislation entails income gains or losses that occur apart from any changes in

12. For more details, see Congressional Budget Office, *Labor Supply and Taxes*, CBO Memorandum (January 1996).

marginal tax rates. Income gains allow people to work less and consume more; losses have the opposite effect.

Many aspects of the reconciliation package provide income gains after taxes. Some provisions reduce taxes and raise income by extending credits, deductions, or exclusions. For instance, the child credit raises the after-tax income of people with children. Similarly, the package allows people who would save even without new individual retirement accounts (IRAs) to reduce their taxes without changing their behavior. Provisions that change tax rates can provide pure income gains in addition to changing marginal incentives. For example, the cut in the capital gains tax enhances the income or wealth of people who have accrued capital gains on previous saving.

Other provisions effectively impose income losses. The package raises excise taxes, reduces payments to Medicare providers, and increases premiums paid by Medicare beneficiaries. On balance, the income losses exceed the gains. Thus, the overall result of those gains and losses will probably be to increase work and decrease consumption, although that net effect again will be small relative to the economy.

Selected Tax Provisions. Under the 1997 reconciliation legislation, the top rate on capital gains drops from 28 percent to 20 percent for gains on the sale of assets held at least 18 months and will eventually fall to 18 percent for gains on assets held for at least five years. Those reductions will raise output slightly by raising the after-tax return on saving, encouraging more saving. But the increase will be small because the new treatment reduces the overall effective tax rate on capital income by less than 1 percentage point, a much smaller reduction than that in the statutory rate on capital gains. The difference occurs because taxes on capital gains are deferred until an asset is sold and because the tax cut does not apply to about three-quarters of capital income—namely, capital gains held until death (which escape tax altogether), ordinary capital income (such as interest or dividends), and capital income paid to tax-exempt investors (such as pension funds).

The Taxpayer Relief Act raises the income eligibility limit for contributions to traditional IRAs and establishes so-called Roth or back-loaded IRAs that allow qualified people to make taxable contributions but earn tax-free income in the accounts. The effect of traditional IRAs on saving is controversial: estimates of the amount of new saving they generate range from zero to over half of total IRA contributions.¹³ Back-loaded IRAs, which account for over half the potential increase

13. For a detailed discussion, see the following articles in the *Journal of Economic Perspectives*, vol. 10, no. 4 (Fall 1996): James M. Poterba, Steven F. Venti, and David A. Wise, "How Retirement Saving Programs Increase Saving," pp. 91-112; Eric M. Engen, William Gale, and John Karl Scholz, "The Illusory Effects of Saving Incentives on Saving," pp. 113-118; and R. Glenn Hubbard and Jonathan Skinner, "Assessing

in IRA contributions, provide no immediate tax benefit for contributions and are thus not as likely to be as effective as traditional IRAs in raising saving. Moreover, published estimates for the response of saving to IRAs are based on traditional rules for withdrawals. The tax act liberalizes those rules by allowing withdrawals for education expenses and first-time home purchases—provisions that will probably moderate any increase in saving by making IRAs more like ordinary savings accounts. Even if one-quarter of estimated new IRA contributions represented additional saving, that increase would add less than 0.1 percent to the level of GDP by 2007.

The tax act also raises the exemption levels that apply to the estate tax and to the alternative minimum tax for small farms and businesses. For estates or businesses that fall between the old and new levels, the higher exemptions reduce marginal tax rates; for larger estates or businesses, the act slightly raises after-tax income and has no effect on the marginal tax rate; and for smaller estates or businesses, the act has no effect at all. Even if the provisions applied at the margin to everyone, they would reduce the overall effective tax rate on capital income by less than one-tenth of a percentage point and therefore could do little to raise national saving and output.

The incentives for education include tax credits for tuition at colleges and vocational schools, exclusions for earnings received from IRAs for education, and tax deductions for interest paid on student loans. Those provisions apply largely to students (or parents of students) who would go to school anyway—72 percent of recent high school graduates already participate in postsecondary education within two years of graduation. Nevertheless, the incentives may encourage some of those who attend part time to attend half time or more and some of those who do not attend at all to do so.¹⁴ In that case, labor supply will initially fall—more time in school is likely to mean less time at work. An increase in schooling, however, should eventually raise both productivity of labor and participation in the workforce, although those positive effects would probably remain negligible during the next 10 years. In sum, the incentives through 2007 will have a small positive effect on enrollment in postsecondary education, a modest positive effect on the intensity of participation in education, and a very small negative effect on total hours worked.

the Effectiveness of Saving Incentives,” pp. 73-80.

14. For estimates of the increase in school enrollment under the Administration’s HOPE scholarship program, which was more generous than the provisions of the Taxpayer Relief Act of 1997, see Steven V. Cameron and James J. Heckman, “Summary of Main Findings” (unpublished paper presented at the Conference on Financing College Tuition hosted by the American Enterprise Institute in Washington, D.C., on May 15, 1997); and Jane Gravelle and Dennis Zimmerman, *Tax Subsidies for Higher Education: An Analysis of the Administration’s Proposal*, CRS Report for Congress 97-581E (Congressional Research Service, May 30, 1997).

Although the tax credit for children does not affect the statutory tax rate on income and its primary effect will be tied to gains in income as noted earlier, that tax credit will also change marginal incentives to work and save. Marginal incentives will fall for high-income families because the credit is phased out at a rate that is equivalent to imposing an extra 5 percent tax on their income. The overall effect will be small, however, because the phaseout now applies only to about 1 percent of earners. Moreover, the adverse impact will be partly offset by an increase in work effort among some low-income parents for whom the credit, which is not fully refundable, effectively raises their after-tax wage rate.

Fiscal Dividend

Policy changes that would significantly reduce the size of the budget deficit can be expected to affect the economy—lowering interest rates and stimulating economic growth. Those economic changes will in turn boost revenues, reduce outlays, and thus lower the budget deficit even more. The extra measure of deficit reduction induced by those economic feedbacks is called the fiscal dividend.

To help legislators and the public assess more realistically the extent of the policy changes needed to balance the budget, CBO prepared economic and budgetary projections that incorporated those dynamic feedback effects in several reports on the economic and budget outlook in the mid-1990s. Because the effects of balancing the budget obviously depend on the baseline projection of the deficit, CBO revised its estimate of the fiscal dividend as the fiscal outlook brightened over that period. CBO also changed its estimate to reflect revised views about the plausibility of some of the forecasts made by outside groups.

CBO's estimates of those economic effects did not assume any specific set of policies to reduce the deficit, even though the types of policies adopted would certainly matter. Deficit reduction that diminished the incentive to work or invest, for example, might have less positive economic effects than those assumed in CBO's analysis. Conversely, policies that stimulated growth in the economy's potential output would have more favorable effects. CBO did not intend for the fiscal dividend to reflect the specifics of any proposal but merely to show the general effects of deficit reduction. (For an example of how CBO would analyze a specific proposal, see the previous section on the 1997 budget reconciliation package.)

Real Growth. By freeing up savings for use in productive investment, balancing the budget allows the economy to grow modestly faster. The beneficial effect on real output of maintaining a balanced budget will be even greater in the long run.

CBO estimated the effects of balancing the budget on real GDP by using its growth model. That model focuses on the supply side of the economy, and the growth of GDP depends on the accumulation of capital, the growth of hours worked, and the advance of technology. It is also the same model that CBO uses to estimate potential GDP.

In CBO's growth model, balancing the budget enhances potential growth because it permits productive resources currently devoted to consumption to be allocated instead to investment. In the near term, the share of total output consumed—either in the provision of government services or as private consumption—will fall, as will consumption. In the long run, however, consumption will be higher because the greater rate of investment will boost total output.

The national saving rate will be higher under a balanced budget, but only about 20 percent of the reduction in the federal government's claim on saving will go toward investment. Two effects will partially offset the influence of deficit reduction on investment: private saving rates will probably fall, and the level of borrowing from foreigners will shrink. The degree to which private saving will fall depends on the particular policies used to reduce the deficit. If the policies do not change incentives to save, the drop in private saving is likely to be between 20 percent and 50 percent of the reduction in the deficit. Private saving is assumed to decline because deficit reduction lowers interest rates and reduces disposable income and future tax liabilities.

The effect of deficit reduction on domestic investment, and therefore on the growth of potential GDP, will also be weakened by reduced borrowing from abroad, but that does not diminish the benefit of deficit reduction to U.S. living standards. Less borrowing from abroad for investment in the United States will reduce the cost of servicing debt held by foreigners, so U.S. living standards will be higher. The effect of lower deficits on gross national product (GNP) is consequently greater than the effect on GDP. GNP includes net claims of U.S. residents on the returns from foreign factors of production, whereas GDP includes only output produced within the United States.

Interest Rates. Balancing the budget would lower interest rates; however, a great deal of uncertainty surrounds that effect. The academic literature reflects the lack of agreement about the precise effect of deficit reduction on interest rates. Because U.S. capital markets are integrated with capital markets worldwide, some economists argue that changes in the federal deficit will have a small effect on interest rates. U.S. rates, those economists maintain, are affected by changes in the worldwide pool of savings and worldwide demands for investment, and the potential deficit reduction is small relative to world markets.

Numerous counterarguments can be made, however. The United States is a large player in world markets, and changes in U.S. saving rates may therefore significantly affect world interest rates. In addition, some empirical studies find that domestic interest rates are affected primarily by changes in domestic saving and investment demand, even in countries with open capital markets. A credible deficit reduction policy would cause domestic saving to rise relative to domestic investment, lowering interest rates.

Given those diverse opinions, the range of estimates of the effect of deficit reduction on interest rates in the academic literature is large. Some investigators estimated that reducing the deficit from 2 percent of GDP to zero would lower rates by about 0.2 percentage points; others argued that rates would fall by about 1.5 percentage points. CBO's January 1997 estimate was 0.7 percentage points, slightly below the midpoint of the range.¹⁵

CBO developed its estimate by weighing results from a variety of macroeconomic models. Models that allow for Keynesian effects, such as those from DRI and Macroeconomic Advisers, produced the largest responses.¹⁶ By contrast, so-called supply-side models tended to show far smaller responses. A simple neoclassical growth model predicted that eliminating a deficit of 2 percent would reduce interest rates by only 0.2 percentage points over a 10-year period. That result stems from the fact that capital's share of income is only 30 percent and balancing the budget would have little effect on the ratio of debt to GDP—and hence the ratio of capital to GDP—after 10 years. Models with mixed features produced estimates between the results of those two kinds of models. For example, simulations with the McKibbin Software Group (MSG) model showed that the same budget-balancing exercise would reduce interest rates by about 0.6 percentage points over 10 years. The MSG model also predicted that although long-term interest rates would decline, short-term rates would jump up at first because demand for investment initially would exceed the supply of saving.¹⁷

Income Shares. Projections of the federal tax bases are affected not only by the total level of nominal GDP but also by how total GDP is allocated among various

15. See Congressional Budget Office, *The Economic and Budget Outlook: Fiscal Years 1998-2007*, Chapter 4.

16. See Roger E. Brinner and Mark J. Lasky, "Model Overview: Theory and Properties of the DRI Model of the U.S. Economy," *DRI/McGraw Hill Review of the U.S. Economy* (August 1997), pp. 41-61; and Macroeconomic Advisers, *Overview of the Washington University Macro Model* (available at <http://www.macroadvisers.com/intro/overvie~.html>).

17. For information about the MSG model, see Warwick J. McKibbin and Jeffrey D. Sachs, *Global Linkages: Macroeconomics Interdependence and Cooperation in the World Economy* (Washington, D.C.: Brookings Institution, 1991).

categories of income. For example, projections that differ only in how GDP is allocated between corporate profits and interest payments can have different implications for deficit projections.

The drop in interest rates and the decrease in the national debt that accompany a policy of deficit reduction suggest a higher share of corporate profits in GDP and a lower share of interest income. Corporate costs for debt service probably would be smaller with lower interest rates, reducing interest expenses and increasing profits. In the longer term, increased investment would raise corporate depreciation, which would offset part of that increase. Other income shares would be affected as well. Dividends would increase slightly, but federal net interest payments would decline.

On balance, the changes in income shares expected to accompany a policy of deficit reduction would increase revenues. Taxable corporate profits would make up a larger share of GDP. Interest income would be smaller, but a hefty portion of interest income accrues to organizations or pension funds that are not subject to tax. Therefore, the shift from interest income to profits would tend to increase revenues.